

Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems

## What leadership pattern can be observed in IPS<sup>2</sup> work systems when compared with production and service?

Bernd-Friedrich Voigt<sup>a\*</sup>, Ksenia Mänz<sup>a</sup> and Uta Wilkens<sup>a</sup>

<sup>a</sup>*Ruhr-University Bochum, Institute of Work Science, Universitätsstraße 150, Bochum 44780, Germany*

\* Corresponding author. *tel.:* +49-234-32-27872; *fax:* +49-234-32-14198. *E-mail address:* [bernd.voigt@rub.de](mailto:bernd.voigt@rub.de)

### Abstract

Research in the field of industrial product service systems (IPS<sup>2</sup>) gives emphasis to the importance of leadership behavior in order to propel new business models. Nevertheless, there is only a little knowledge of what leadership pattern is crucial and makes a difference in comparison to production and service. In our paper we address leadership behaviors and empowerment in IPS<sup>2</sup>, trying to shed light on qualitative structural differences compared to product- and service-oriented work systems. We present data from an empirical survey among 172 engineers in Germany. The participants evaluated psychological and structural empowerment and perceived interactive leadership behaviors. These aspects built the basis for explorative factor analyses conducted for each work system separately. Comparative qualitative interpretations of the results show that there are three different patterns of leadership. In an IPS<sup>2</sup> work system, leadership shows a contextualized configuration in which specific behaviors and empowerment components fuse within factors. The resulting pattern is compared to product- and service-oriented work systems. Detailed analyses display a pattern in IPS<sup>2</sup>-oriented work systems in which a combination of leadership behaviors and empowerment elements supporting strategic goal-orientation, transparency and positive sensemaking makes up the difference in comparison to both other work systems.

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Selection and peer-review under responsibility of the International Scientific Committee of “The 6th CIRP Conference on Industrial Product-Service Systems” in the person of the Conference Chair Professor Hoda ElMaraghy”

*Keywords:* IPS<sup>2</sup>; leadership; human factor

### 1. Introduction

A work system is defined as “a system in which human participants and/or machines perform work using information, technology, and other resources to produce products/services for internal and/or external customers” [1]. This framework implies a possible scheme in which traditional product- and service-oriented work systems can be classified according to specific work system characteristics. Industrial Product-Service Systems (IPS<sup>2</sup>) integrate in this scheme as they are designed to build a shared value creation combining production and services with a high degree of customer integration [2]. This demands dynamic inter-organizational and cross-functional cooperation along the lifecycle of the IPS<sup>2</sup> [3]. By this, IPS<sup>2</sup> constitute unique and significantly complex work systems going beyond organizational

boundaries [3] requiring for new inter-organizational routines of cooperation and exchange in a dynamic change process [4,5]. This also means that the way of how to cope with customer demands in the provided business model influences the characteristics of the work system and leads to high demands for the human participants. With respect to this background several publications have recently pointed out the importance of a human factor perspective in understanding professional IPS<sup>2</sup> management including all actors, employees as well as leaders [6-10].

This gives emphasis to leadership behaviors and leadership styles [7,11,12]. We understand leadership as an interaction whereby a leader influences the behavior of followers to achieve organizational goals [13]. The influencing behavior can be based on personal interaction with employees or teams as well as structural elements or empowering working

conditions [14,15]. While there seems to be no doubt that effective leadership is based on different behaviors and approaches in different contexts [16], there has been no precise empirical research in what leadership pattern can be attributed to IPS work systems.

The objective of this paper is to go into more detail by a comparative analysis of leadership in IPS-, product- and service-oriented work systems<sup>1</sup> in order to shed light on possible differences.

## 2. Conceptual background of leadership in IPS<sup>2</sup>

Solution selling instead of product or service selling is considered a suitable answer to hyper competition in competitive theory, since it entails a sustainable offer to continuously developing customer demands [17-19]. According to previous empirical research [20] there are clear indicators that an IPS work system in operation distinguishes from traditional product-oriented work systems. IPS<sup>2</sup> can be characterized as a network-based environment with very open innovation processes where collective knowledge creation and on-the-job-development for new problems is more important than experience-based learning. Compared to service-oriented work systems an IPS<sup>2</sup> can be characterized as a work system with a higher degree of standardization. This research also supports assumptions about the differentiating role of leadership with respect to these work systems [20].

A key challenge of an IPS work system with respect to leadership behaviors is the high need for cooperation among participants from different fields of an organization who have to leave their traditional working backgrounds and working cultures [21]. An IPS work system demands for a continuous monitoring of (de-)centralized decision-making and explorative and cooperative learning strategies [22-24], while, at the same time ensuring exploitative capacities in structures and processes [25,26]. Jansen, Vera and Crossan [27] underline the influence of environmental dynamics on the effectiveness of leadership for exploration and exploitation. They line up with theories postulating the contextual specificity of effective leadership styles [16].

Going into more detail in research on leadership styles different approaches need to be taken into consideration. Transactional leadership behaviors focus on task orientation and on each employee's achievement of specific goals [28,29]. They are directed at facilitating, improving and extending existing knowledge, and thus, support exploitative learning [26,39,31] which seems to be especially important with respect to the revenues gained from IPS<sup>2</sup> but also important for the internal coordination needs. The transformational approach of leadership indicates that the leaders' vision and intellectual stimulation contribute significantly to adopting generative thinking and pursuing exploratory learning [32-34]. This might be especially important in the initiating period for IPS work systems. Delegation and empowerment provide

employees with the resources and information needed to cope with current challenges and enable them to organize their work and co-work with colleagues in autonomous ways [14]. Considering the decentralized responsibilities in IPS<sup>2</sup> this might be an important success factor as well. Due to the specific work system characteristics we assumed a unique pattern of leadership behavior under conditions of a dynamic IPS<sup>2</sup>. We use a comparative research approach to reveal qualitative structural differences in leadership patterns.

## 3. Data collection and research methods

We designed an empirical study in order to address "what leadership pattern can be observed in IPS work systems when compared with production and service." An online-based survey was conducted among German engineers from summer 2012 to spring 2013 with a return of 172 questionnaires.

In order to cover a wide spectrum of leadership behaviors, we used items for transformational leadership from the Global Transformational Leadership Scale suggested by Carless [35], and items for task orientation and laissez faire leadership (inversely coded) from the Multifactor Leadership Questionnaire suggested by Bass and Avolio [36] and translated into German by Felfe [37]. Laissez faire items were included inversely coded to gain information about the degree of leaders' personal involvement indicating immediate troubleshooting behaviors. The pool of items from the transactional sphere was enlarged by questions that were developed tailor-made for this study to explicitly cover contingent reward behaviors. Aspects of empowerment as an indicator for the characteristics of structures, rules and processes were measured according to the operationalization of Spreitzer as a combination of structural [14] and psychological empowerment [15]. Appendix A shows the list of items used in the analysis. Respondents gave answers on a seven-step Likert scale, with "1" meaning "I totally disagree" and "7" meaning "I totally agree."

The total sample of 172 engineers shows the following characteristics: twenty-two (12.8%) of the respondents were women and 148 (86.0%) were men. Two (1.2%) respondents did not report their gender. The majority of respondents is aged between 30 to 49 years (57.5%), has a university or advanced technical college degree (87.8%) and has more than five years of working experience (61.6%).

The types of work systems were measured according to the description of organizational offer as measured by Cova and Salle [38] (for more details, see [20]). Table 1 displays the distribution of the sample between different work systems.

Table 1. Distribution of the sample between different work systems

Type of Work System	Respondents	Percent
IPS <sup>2</sup>	68	39.5
Production	51	29.7
Service	52	30.2
Not specified	1	0.6
Total	172	100

<sup>1</sup>We use the following abbreviations so as not to impede the reading flow: "IPS<sup>2</sup>" for PSS- or IPS<sup>2</sup>-oriented work systems, "production" for product-oriented work systems, and "service" for service-oriented work systems.

Three exploratory principal component factor analyses were conducted system-wise to identify typical structures of leadership behaviors for all working systems. The method of a factor analysis was chosen because its mathematical logic is based on the phenomenon by which a larger set of items structures into separate factors on the basis of an inherent logic. Its meaning can be interpreted by analyzing specific item combinations within one factor, especially in the context of other factors. An explorative factor analysis is open to new combinations and new segregations, even if included sets of items stem from established scales. Thus, we allowed behaviors from four different and established leadership approaches to reconfigure in a specific way in which the work system defines a context that can be considered to have an essential structuring influence.

Each of the three principle component factor analyses was based on a “Varimax rotation.” Only factors that accounted for an “Eigenvalue” greater than 1 were extracted [39]. The factor solutions were optimized step-wise accepting Kaiser-Meyer-Olkin criterion (KMO) above 0.6 [40] and a minimum variance explained of 65%. The results of scree tests [41] were also taken into consideration. Twenty-seven selected items were suitable for all three solutions. Table 2 shows the overall statistical information of the three analyses.

Table 2. General information about the factor analyses

Type of Work System	Production	IPS <sup>2</sup>	Service
Number of items	27	27	27
KMO*	0.815	0.882	0.787
Variance explained	0.740	0.662	0.667
Communalities range	0.543 - 0.858	0.459 - 0.814	0.435 - 0.814

\*Kaiser-Meyer-Olkin

Structural differences and similarities regarding leadership behaviors are displayed by the allocation of specific leadership behaviors attributed to one of four leadership approaches within factors calculated system-wise. Cross loadings were tolerated to provide a broader basis for qualitative interpretation about if and why specific behaviors were allocated to more than one combination of behaviors.

Our analysis of the principal component matrix considers two dimensions determining the level of structural difference. A vertical assessment sheds light on the extent to which items from different leadership approaches fuse within factors including: a) the combination of leadership behaviors and empowerment elements within factors, and b) the allocation of immediate troubleshooting behaviors (*laissez faire* inversely coded) within factors. A horizontal assessment shows the extent to which behaviors from established leadership approaches decompose into separate factors including: c) the extent of structural segregation between different leadership styles and d) the extent of segregation between interactive leadership behaviors and empowerment.

#### 4. Results

The rotated component matrixes with all data are displayed in Appendix A. Items with loadings above 0.4 were taken into consideration for further interpretation.

An assessment regarding the segregation reveals a decrease in the number of factors from production to IPS<sup>2</sup> to service.

We can identify a clear separation between structural empowerment and interactive leadership behaviors for all work systems. The extent, however, to which behaviors from the transactional and/or transformational sphere are partly allocated to other factors decreases from production to IPS<sup>2</sup> to service. Within service, we observe a clear separation between psychological and structural items of empowerment, whereas in production and in IPS<sup>2</sup> most empowerment elements fuse within one factor.

An assessment regarding the combination of leadership behaviors and empowerment elements within factors uncovers that all work systems show a first factor integrating most items from transactional and transformational leadership. The extent, however, to which behaviors from different spheres fuse within factors increases from production to IPS<sup>2</sup> to service. Empowerment elements do not integrate into the first factor in all work systems.

We can observe especially in IPS<sup>2</sup> that empowerment elements form a separate factor which is almost unconnected to interactive leadership behaviors. We assume that decentralized decision-making and accessible information and resources are of major relevance in this work system, and thus, demand a distinct leadership approach supporting explorative learning. Only one exemption can be found for the empowerment item “transparency of organizational strategies, visions and goals,” which fuses with items regarding overall optimism and elements of project-focused Management by Objectives (MbO) covering goal setting, monitoring and contingent reward. Immediate troubleshooting behaviors combine with transformational and transactional leadership behaviors within one factor.

We can observe in production that the empowerment item of “access to information” is connected to goal-orientation as well as to transformational leadership behaviors regarding support for problem-solving and creativity. Other empowerment components combine with different items from the transformational sphere, with some items related to contingent rewarding and additionally with items indicating immediate troubleshooting behaviors. It can also be observed that active problem-solving and creativity in production are less connected with transformational behaviors, but are rather linked to task-orientation and behaviors enforcing the division of labor.

We can observe in service that items from the structural empowerment scale form an isolated factor and, by this, clearly separate from items of psychological empowerment and interactive leadership behaviors. Items of psychological empowerment fuse with those transformational and transactional leadership behaviors which support creative and efficient problem-solving. Immediate troubleshooting behaviors combine with most of the transformational and transactional leadership behaviors within one factor.

Leadership in both IPS<sup>2</sup> and service seems to be a more complex and less fragmented responsibility, integrating more and even ambidextrous behaviors within factors. A higher structural separation of leadership and empowerment is observed for production. The overall comparative analysis of structural differences in leadership between production, IPS<sup>2</sup> and service shows three patterns, each of which is a specific result of different levels of both segregation and a combination of leadership behaviors and empowerment elements (see Fig. 1).

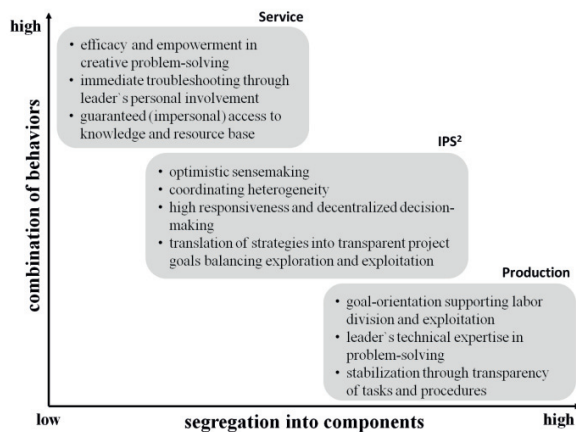


Fig. 1. Leadership patterns in IPS<sup>2</sup>, production and service.

## 5. Discussion

It becomes obvious when comparing the three work systems that components from both psychological and structural empowerment arise to play an important role in understanding the qualitative meaning of the structural differences observed. If behaviors from transactional leadership (mostly MbO-Items) and the transformational sphere are fused with empowerment, it is important to know which specific empowering element is addressed.

Goal- and task-orientation in both production and IPS<sup>2</sup> appear to be particularly important and almost independent elements of leadership. However, the challenge for leadership to translate strategies into measurable global task-related goals, and thus, to act as an optimistic sensemaker is unique for IPS work systems. We assume that actors' heterogeneity resulting in high coordination demands, uncertainty about the relation between leadership behaviors and expected outcomes, and novel problems without reference solutions call for a more encompassing leadership approach. In production and in service sensemaking and optimism cannot be singled out as a separate leadership responsibility, but relate rather to everyday transformational behavior. We assume that in IPS<sup>2</sup> especially, the uncertainty of employees about future developments and the lack of established organizational routines demand such a distinct combination of leadership behaviors.

In both IPS<sup>2</sup> and service, we observe high responsiveness and immediate troubleshooting (*laissez faire* inversely coded) closely connected to transformational and transactional leadership behaviors focusing on encouragement and support. We interpret this combination of leadership behaviors as being caused by the need for the perceived personal presence of leaders as reliable and efficient problem-solvers, whenever needed. In production, the perceived presence and immediate troubleshooting behaviors of leaders combine with transactional leadership behaviors focusing on goal orientation and access to resources building up a separate factor. We assume that this difference is caused by the nature of problems in different work systems addressing exploitative,

technical aspects in production and more explorative, coordinative aspects in IPS<sup>2</sup> and service.

## 5. Conclusion

Former studies proposed the important impact of leadership on IPS<sup>2</sup> performance [7,11,12]. Our analysis identifies a leadership pattern in IPS work system that can be regarded as distinct when compared to production and service. The high responsiveness of interactive leadership in IPS work systems is combined with the responsiveness of decentralized decision-making and action as important elements of empowerment. This is seen as a solution of an IPS work system to its specific leadership challenges. Transparent goal orientation in combination with sensemaking and strategic orientation of empowerment can be identified as another essential element of leadership in IPS<sup>2</sup>. We interpret this as a solution in order not to lose direction and to balance exploration with exploitative procedures. The IPS<sup>2</sup> pattern is seen as characteristic because it merges two solutions by which leaders can be described as: a) encouraging and guiding sensemakers and immediate general (rather than technical) problem-solvers, while simultaneously enabling b) decentralized actions through structural and psychological empowerment.

Our analysis adds a further differentiation to former research that transformational leadership has an important contribution but cannot explain the differences between different working contexts by itself. The difference to production and service is based on a specific way of contextualizing transformational and transactional leadership behaviors and combining them with elements from psychological and structural empowerment. Our explorative approach does not allow inferences whether the stated solutions are effective and efficient, but we assume their practical relevance as they prevail in the IPS work system observed when compared to production and service.

Our research aim has highlighted structural differences between leadership patterns, although the qualitative analysis also reveals similarities, across all three work systems. These findings give further motivation for research addressing which organizational routines and leadership patterns are likely and useful to be incurred in the development process towards an IPS work system and which ones should be "left behind."

Finally, our research shows that the analysis of leadership behaviors and empowerment plays an important role in understanding the contextual configuration of a work system. In this way, we add another layer to work system theory by describing specific patterns of how human participants' interaction can be orchestrated with regard to specific work system challenges.

Appendix A

Rotated Principle Component Matrix <sup>a</sup>											
Leadership styles	Items	Production				IPS <sup>2</sup>			Service		
		Factor				Factor			Factor		
		1	2	3	4	1	2	3	1	2	3
Empowerment	I have access to all information I need, to do my job well.	0.107	0.275	<b>0.596</b>	0.362	0.126	0.272	<b>0.741</b>	-0.033	0.120	<b>0.854</b>
	I have access to all resources I need, to do my job well.	0.131	<b>0.577</b>	0.053	<b>0.582</b>	0.299	0.103	<b>0.712</b>	0.106	0.217	<b>0.669</b>
	I understand the strategies, visions and goals of my organization.	0.037	0.238	0.302	<b>0.627</b>	0.125	0.520	<b>0.419</b>	0.077	0.183	<b>0.782</b>
	I can decide independently in what way to do my job.	0.392	-0.009	0.249	<b>0.772</b>	0.000	0.104	<b>0.824</b>	0.004	<b>0.798</b>	0.203
	I have sufficient scope for possible actions in my job.	0.225	0.029	0.026	<b>0.835</b>	0.254	-0.033	<b>0.739</b>	0.004	<b>0.804</b>	0.273
	I have essential influence on my working environment.	0.313	0.147	0.219	<b>0.765</b>	0.127	0.224	<b>0.664</b>	0.008	<b>0.817</b>	0.175
Transformational leadership	... communicates a clear and positive vision of the future.	<b>0.605</b>	0.344	0.333	0.281	<b>0.664</b>	<b>0.409</b>	0.246	<b>0.661</b>	0.390	0.055
	... treats staff as individuals, supports and encourages their development.	<b>0.855</b>	0.119	0.184	0.115	<b>0.772</b>	0.377	0.232	<b>0.756</b>	0.104	0.274
	... gives encouragement and recognition to staff.	<b>0.849</b>	0.224	0.060	0.195	<b>0.814</b>	0.276	0.264	<b>0.874</b>	0.085	0.097
	... fosters trust, involvement and cooperation among team members.	<b>0.848</b>	0.225	0.177	0.236	<b>0.805</b>	0.251	0.244	<b>0.759</b>	0.161	0.202
	... encourages thinking about problems in new ways and questions assumptions.	<b>0.686</b>	0.065	<b>0.523</b>	0.179	<b>0.631</b>	0.158	0.169	<b>0.447</b>	0.551	-0.353
	... is clear about his/her values and practices that he/she communicates and acts as an example.	<b>0.677</b>	0.202	0.256	0.243	<b>0.817</b>	0.306	0.166	<b>0.825</b>	0.335	-0.147
... installs pride and respect in others and inspires me by acting highly competently.	<b>0.546</b>	<b>0.650</b>	0.292	0.089	<b>0.771</b>	0.347	0.198	<b>0.773</b>	0.194	-0.050	
Transactional leadership	... is not afraid of talking about problems in an open manner.	0.315	0.381	<b>0.531</b>	0.389	<b>0.601</b>	<b>0.442</b>	-0.005	<b>0.840</b>	-0.057	-0.080
	... sets clear goals.	0.369	<b>0.467</b>	<b>0.595</b>	0.215	0.203	<b>0.846</b>	0.124	<b>0.579</b>	<b>0.410</b>	0.260
	... delegates demanding tasks.	<b>0.617</b>	0.074	0.233	0.349	<b>0.536</b>	0.311	-0.085	<b>0.588</b>	0.298	-0.023
	... is present as a contact person if problems arise.	<b>0.642</b>	<b>0.491</b>	0.189	0.261	<b>0.708</b>	0.220	0.356	<b>0.802</b>	0.051	0.307
	... has transparent evaluation criteria for my achievements.	<b>0.624</b>	0.292	<b>0.596</b>	0.092	<b>0.566</b>	0.532	0.317	<b>0.735</b>	<b>0.404</b>	0.207
	... is supportive in difficult situations.	<b>0.757</b>	0.348	0.279	0.214	<b>0.717</b>	0.261	0.306	<b>0.867</b>	0.157	0.082
	... always keeps our project goals in focus.	<b>0.488</b>	<b>0.672</b>	0.139	0.080	<b>0.487</b>	<b>0.476</b>	0.146	<b>0.779</b>	0.065	-0.085
	... offers help in return for my efforts.	<b>0.635</b>	<b>0.457</b>	0.347	0.017	<b>0.783</b>	0.293	0.286	<b>0.721</b>	-0.236	0.357
	... makes clear who is responsible for which achievements.	<b>0.463</b>	0.282	<b>0.696</b>	0.217	<b>0.480</b>	<b>0.676</b>	0.091	<b>0.743</b>	0.057	-0.166
	... is transparent about what to expect if goals are reached.	0.320	0.170	<b>0.814</b>	0.157	0.301	<b>0.785</b>	0.311	<b>0.765</b>	0.241	0.049
... shows satisfaction if others live up to expectations.	<b>0.715</b>	0.282	0.223	0.276	<b>0.745</b>	0.269	0.268	<b>0.757</b>	-0.127	-0.054	
Laissez faire (inversely coded)	... is always there when needed.	0.369	<b>0.710</b>	0.050	0.224	<b>0.768</b>	0.175	0.348	<b>0.810</b>	0.096	0.180
	... decides fast and without hesitation.	0.077	<b>0.821</b>	0.321	-0.013	<b>0.795</b>	0.001	0.018	<b>0.760</b>	-0.233	-0.118
	... clarifies important questions immediately.	0.196	<b>0.798</b>	0.328	0.185	<b>0.834</b>	0.050	-0.038	<b>0.850</b>	-0.220	0.072

Extraction: Principle component.  
 Rotation: Varimax.  
 Bold type number marks item loading on a factor >0.4.  
 Grey background marks items tailor-made for this study.



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