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# REGULAR PAPER
# Participatory modeling to support gender equality
## The importance of including stakeholders

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## Abstract

**Purpose** – Interventions to support gender equality in organisations are often unsuccessful. Stakeholders disagree about the causes and problem definition of gender equality or pay lip service to the principle of gender equality, but fail to implement gender equality in practice. The purpose of this paper is to examine participatory modelling as an intervention method to support stakeholders in: reaching a shared problem definition and analysis of gender inequality; and identifying and implementing policies to tackle gender inequality.

**Design/methodology/approach** – The authors apply participatory modelling in case studies on impediments to women's careers in two Dutch universities.

**Findings** – This study shows that participatory modelling supported stakeholders' identification of the self-reinforcing feedback processes of masculinity of norms, visibility of women and networking of women and the interrelatedness between these processes. Causal loop diagrams visualise how the feedback processes are interrelated and can stabilise or reinforce themselves. Moreover, they allow for the identification of possible interventions.

**Research limitations/implications** – Further testing of the causal loop diagrams by quantifying the stocks and the flows would validate the feedback processes and the estimated effects of possible interventions.

**Practical implications** – The integration of the knowledge of researchers and stakeholders in a causal loop diagram supported learning about the issue of gender inequality, hereby contributing to transformative change on gender equality.

**Originality/value** – The originality of the paper lies in the application of participatory modelling in interventions to support gender equality.

**Keywords** Academic staff, Careers, Organizational change, Gender equality, Participatory modelling, Causal loop diagrams

**Paper type** Research paper

Scholars increasingly investigate interventions to support gender equality in organisations, yet thus far a recipe for ultimate success has not been found. The debate on interventions focuses both on the theoretical foundations of interventions (Ely and Meyerson, 2000; Meyerson and Kolb, 2000) as well as the empirical support for success of the interventions in reaching gender equality (Kalev *et al.*, 2006). The theoretical debate

focuses on whether gender equality interventions should be directed at changing organisational structures or at supporting the agency of individuals in organisations. A strong argument for interventions aimed at changing structures is made by Meyersen and Kolb (2000), who maintain that only interventions directed at transforming organisational processes ("Revising organisational discourses") are able to achieve gender equality. They contrast this approach to interventions aimed at changing individuals (e.g. "Equipping the women" and "Creating equal opportunities"), which keep socially constructed gender differences in place. In contrast, de Vries (2012) argues that interventions aimed at individual agency may transform organisations as a side effect. Mentoring programmes, for example, aimed at "equipping the women", may change mentors' understanding on how gender is socially constructed and so support changes in organisational processes.

Empirical research comparing success of diversity interventions shows that interventions directed at increasing organisational responsibility for gender and race equality are more successful than interventions aimed at training managers and reducing social isolation of disadvantaged groups (e.g. by mentoring or networking programmes) (Kalev *et al.*, 2006). Moreover, this large scale, longitudinal study of diversity interventions shows that organisational responsibility also boosts the effectiveness of interventions aimed at women's agency and training managers. It is thus highly likely that the commitment of stakeholders (e.g. managers) is key to the success of gender inequality interventions. Analyses of gender equality interventions reveals that commitment of stakeholders is often lacking (Benschop and Verloo, 2006; Connel, 2006).

Managers' lack of commitment can appear in different phases of interventions, i.e. during problem definition, problem analysis, design of the intervention, implementation of the intervention and evaluation (Verschuren and Doorewaard, 2010). First of all, research shows that stakeholders often do not see gender inequality as a problem in their organisations (Ely and Meyerson, 2000). Second, stakeholders may not agree on the causes of gender inequality or show resistance when discussing these issues (Benschop and Verloo, 2006). Third, gender equality interventions may fail in the design and implementation phase. Stakeholders often pay lip service to the principle of gender equality, but fail to implement gender equality in practice (Benschop and Verloo, 2006). We aim to better understand how interventions can be more effective in reaching gender equality in organisations by examining a method that supports the involvement of stakeholders in reaching a shared problem definition, supports their understanding of the causal mechanisms underlying gendered processes and supports stakeholders in identifying possible interventions. In this paper, we examine the results of a particular intervention method, participatory modelling, on tackling gender equality. In the following we discuss the intervention method of participatory modelling and subsequently apply the method of participatory modelling in two case studies on impediments to women's careers in Dutch academia.

## Participatory modelling to support gender equality
Participatory modelling is an intervention method, which refers to "sitting with a group of problem owners and building and playing with a system dynamics model to help them tackle an organizational issue" (Lane, 2010, p. 461). The modelling part of this definition refers to the researchers' practice of translating messy problems in causal loop diagrams that reveal the dynamic structure underlying the issue. The causal loop diagrams show the feedback processes at work and support the simulation of the effect of changes in the system over time (Forrester, 1987). Participative (qualitative)

modelling has been used to support interventions in social systems (Rouwette *et al.*, 2015; Rouwette *et al.*, 2002).

The participatory element of this research method refers to the researchers' practice of involving problem owners or stakeholders in the various stages of a (qualitative) modelling process. Building causal loop diagrams with groups of people has become a full sub discipline of system dynamics named Group Model Building (GMB) (Andersen *et al.*, 2007; Richardson and Andersen, 1995; Vennix, 1996). GMB refers to a series of meetings where a professional facilitator supports a group of stakeholders in building a causal loop diagram of an organisational problem. The method is mainly applied to support strategic decision-making in organisations. It is especially suited to tackling messy problems, defined as problems in which people hold entirely different views on whether there is a problem, and if they agree; and what the problem is (Vennix, 1996; 1999).

Vennix (1999) distinguishes three reasons to involve stakeholders in participatory modelling. The first is to capture the required knowledge in the mental models of these organisational members. Building a model together helps to elucidate the knowledge of individual participants and enhance team learning. The second is to foster consensus on the causes and consequences of a messy problem. The causal loop diagram is a product of common deliberation and so helps to integrate knowledge. The third is to create commitment with a resulting decision. Since the model is the product of a group process, the participants are supposed to feel connected to the decisions that are enacted from it and to support their implementation.

We consider gender inequality a messy problem, as stakeholders are found to disagree on the causes of gender inequality or whether it is a problem at all. In the next paragraph we present two cases in Dutch academia where we applied participatory modelling to support gender equality. More specifically, we addressed the slow pace of organisational change as regards gender inequality in academia (Bleijenbergh *et al.*, 2013a; Van den Brink and Benschop, 2012) as part of a bigger effort to help create a "free democratic society" (Denzin and Lincoln, 2008). We hoped the participatory modelling would foster consensus amongst stakeholders on the messy problem of impediments to women's careers in academia and create commitment to the decisions they would take based on the research results.

## The two cases

The participative modelling was performed as part of two applied research projects on impediments to women's careers in academia in the period 2007-2008 at a Social Sciences and Humanities University and 2009-2010 at a Technical University, both in the Netherlands. The first two authors were senior researcher and project leader, respectively, working with a team of about ten other researchers and research assistants in each research project. Before we discuss the results of the modelling process and the development of interventions, we give below some more information about the context of the projects.

At the Social Sciences and Humanities University, we involved all five constituent schools in our case-study, namely the schools of Economics and Management, Humanities, Law, Social Sciences and Theology. At the start of the project, in 2007, the proportion of women as full professors was 8 per cent compared with a Dutch average of 10 per cent (Gerritsen *et al.*, 2009). Women represented 56 per cent of the PhDs and 47 per cent of the post-docs. At the assistant and associate professor level women made up 32 and 16 per cent of the personnel, respectively.

At the Technical University, we involved two out of eight schools in our case-study, namely the school of Maritime, Mechanical and Technical Engineering and the school

of Civil Engineering and Geoscience. At the start of the research project at the Technical University in 2009, women made up 22 per cent of the total number of academic staff. At PhD and post-doc levels, the proportions of women were 26 and 25 per cent, respectively. Of the assistant professors, 21 per cent were women and of the associate professors 7.6 per cent were women. As mentioned, women made up 6 per cent of the full professors, compared with a Dutch average of 12 per cent in 2008 (Gerritsen *et al.*, 2009). The proportion of women as full professors at the two schools that were included in the participatory model building sessions were below average for the university (4 and 0 per cent).

## Method
To prepare the participatory modelling we held in-depth interviews with 44 academics (managers, men and women academics in high and low positions) from the five constituent schools of the Social Sciences and Humanities University (see Table I). We used sensitising concepts from the existing body of knowledge concerning the position of women in academia to develop open-ended questions (Van Engen *et al.*, 2011). The interviews were transcribed verbatim. The results of the interviews were discussed in a series of five focus groups with 28 of the interviewees and in a series of five focus groups with 34 stakeholders (deans, HR advisors and department chairs). To examine the two constituent schools of the Technical University, we held in-depth interviews with 14 academics, based on the same questionnaires as the first research project. To increase the number of academics involved, we held focus groups with another set of academics (12), making the total number of interviewees at the two schools 26.

### Focus groups
In both universities, we held focus groups in the different schools to corroborate our findings and deepen our understanding of the processes taking place. Moreover, the focus groups enabled us to correct interpretation problems. In the first research project (Social Sciences and Humanities University), we held focus groups with interviewees and an additional series of five focus groups with the deans and heads of departments of the constituent school. We briefly presented the results of our analysis, and asked the participants to reflect on the results and come up with suggestions for action. The findings of the focus groups further improved our understanding of the processes and were input for the model building by the research team. In the second research project, we also briefly presented our results to the interviewees to corroborate them. Moreover, we involved the deans and heads of departments directly in the analysis and interpretation of the results by presenting them with our first results and inviting them to build a causal loop diagram of the situation at their school.

| | PhD students | Post-docs | Assistant professors | Associate professors | Full professors | |
|---|---|---|---|---|---|---|
| Social Sciences and Humanities University | 56 | 47 | 32 | 16 | 8 | **Table I.** |
| Technical University | 26 | 25 | 21 | 8 | 6 | Proportion of women academics |

*Modelling process*
We performed participatory modelling according to the method developed by Vennix (1996). In the Social Sciences and Humanities University, in total four meetings of approximately three hours were devoted to the model building effort. The sessions were conducted by a professional facilitator and a computer modeller, with five members of the research team participating. In the Technology University, we used a comparable format, but the level of analysis modelling was directed at the schools rather than the whole university. Besides the researchers (three), stakeholders from the School of Civil Engineering and Geosciences (six) and the School of Maritime, Mechanical and Technical Engineering (seven) took part in the sessions.

**Results**
The detailed causal loop diagrams resulting from the modelling sessions depicted the situation at the specific university and schools and can be found in the separate research reports (van Engen *et al.*, 2008; van Engen *et al.*, 2010). On the basis of a comparison of the two causal loop diagrams, we found that the generic structures of the causal loop diagrams were comparable, although certain feedback processes were characteristic for a particular university. Here, we first discuss the generic structure and then the feedback processes typical for each university. In the discussion, we relate our results to the existing theoretical debates about gender in academia and describe how the model was translated in policy recommendations.

**Generic structure**
The basic elements of the generic structure that appeared in all cases were the stock and flow of women's careers, the feedback process of the masculinity of norms, the feedback process of the visibility of women and the feedback process of womens' networks. We explain the different basic elements below.

*Stock and flow of women's careers*
At the core of the causal loop diagrams is the stock and flow of women's careers (Figure 1). A stock is a unit which increases or decreases during a specific time interval. In this case the stocks represented the proportion of women in lower and higher
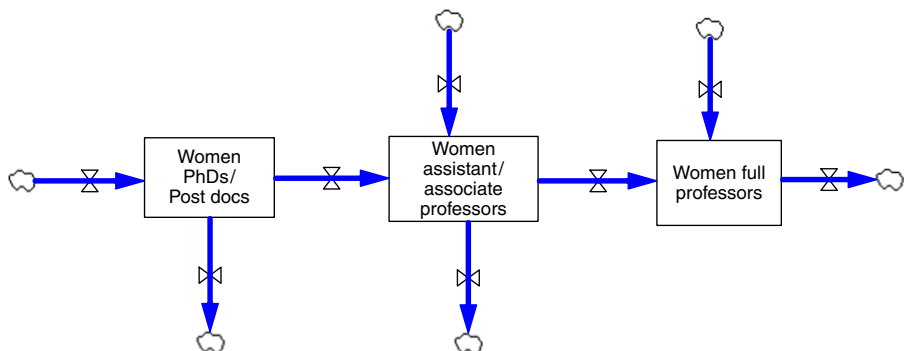


**Figure 1.**
Stock-and-flow of women's careers

**Notes:** Boxes represent the stocks (number) of women in a certain position in an organization. Arrows with hourglasses represent flows of women between positions over time. Clouds represent stocks of women outside the organization

academic positions at the specific moments of research. A flow indicates the quantity by which a stock changes during a specific time interval. In these cases the flows represent the proportions of women who were flowing from lower to higher academic positions per year. The values of the stocks were the proportions of women in different ranks at the moment of the case-study (see above). In both projects we used the stock-and-flows to represent the strong decrease in the proportion of women in the successive levels of the academic hierarchy.

*Feedback process of the masculinity of norms*
The feedback process of the masculinity of norms is a second basic element of the generic causal loop diagram. Feedback processes show circular causality between a (series of) variables. Arrows between variables with a positive sign indicate that an increase of variable A leads to an increase of variable B. A negative sign indicates that an increase in the value of variable A leads to a decrease of variable B (Richardson, 1991). The masculinity of norms was identified during the modelling process as an important value influencing the flow of women to higher academic ranks. Both male and female interviewees referred to masculine norms. This is illustrated in the following account from an interview:

> To what extent do you think your policy creates unintended obstacles to hiring, selecting and promoting women?

> Culture is the only thing that springs to mind. The culture of material engineering, even more so the culture of maritime engineering, it's quite no nonsense. It does have its positive sides […] but […] um […] it's still a masculine culture (Dean of Technology University, man).

The content of masculine norms differed slightly for the two universities and also between schools (Van Engen *et al.*, 2008, 2010). The Social Sciences and Humanities University defined masculine norms as an emphasis on fulltime work, a culture of overwork and valuing research over education. In the Technology University, masculine norms included an emphasis on quantity rather than quality of research output, an emphasis on applicability of output in society and an emphasis on researcher's individual visibility in the media rather than on group performance. The common denominator was that both men and women academics called it a culture of masculinity. The participants recognised that masculinity of norms entails a self-reinforcing feedback process when it comes to the proportion of women in higher academic positions (see Figure 2). When the proportion of women in higher academic positions decreases, the masculinity of the norm increases. This has a negative effect on the congruence of women academics to the standard of the ideal academic. The facilitator identified this as a positive feedback loop, which is represented in Figure 2 with the symbol of a snowball. If the proportion of women in higher academic positions increases, norms become less masculine, thereby increasing the perceived congruence of women with the ideal academic, and decreasing the proportion of women flowing out of higher and lower academic positions, while increasing the proportion of women being promoted from lower into higher academic positions. This finally leads to a higher proportion of women in higher academic positions. An example of such a situation is found in the School of Law in the Social Sciences and Humanities University, which has a higher proportion of women in high positions (16 per cent) than average. Here, the norms
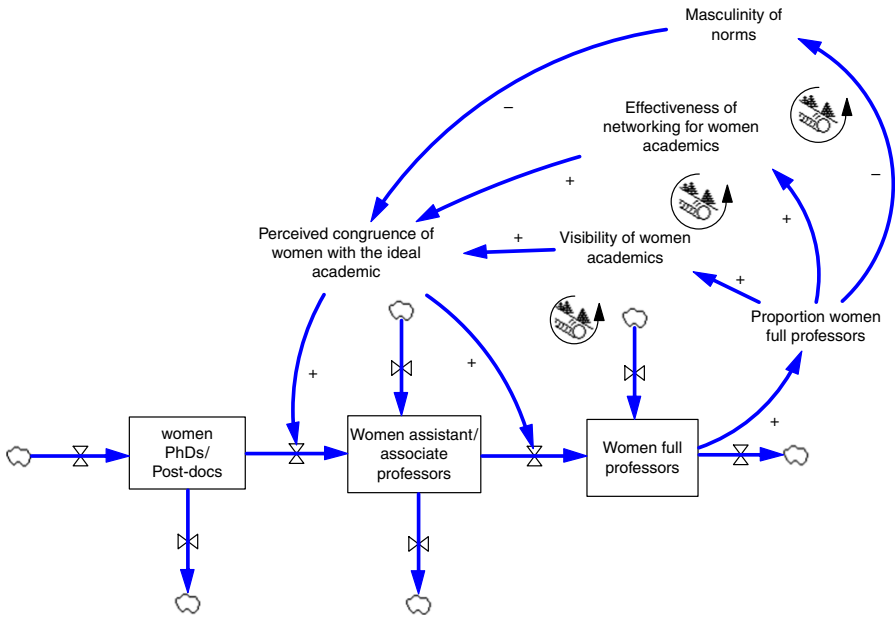
**Figure 2.**
Feedback processes
explaining gender
inequality

**Notes:** Arrows with a minus represent a negative relationship: Increases in a value of a variable lead to decreases in another variable or relationship. Arrows with a plus represent a positive relationship: Increases in a value of a variable lead to increases in another variable or relationship. Snowballs represent a positive feedback loop: a self-reinforcing feedback process between a (series of) variables

are less masculine than in other schools, emphasising the value of education and putting less emphasis on fulltime work than other schools.

*Feedback process of the visibility of women academics*
The second feedback process recognised in both universities related to the visibility of women academics. The variable is connected to the extent to which women academics are perceived to be congruent with the ideal academic:

As for me, myself, I wonder if I really am the scientist who […] um […] if I really fit *the* image. And this image, I have a view of it and the organisation has its own view of it as well. I don't know if I would be all that happy if I did fit the university's image (Assistant Professor at Technology University, woman).

The modelling shows that in both universities the visibility of women academics entails a self-reinforcing feedback process (Figure 2). The proportion of women in higher positions positively relates to the visibility of women. As the overall proportion of women academics increases, so too does their visibility in and outside the organisation. In turn, there is greater perception of the congruence of women with the ideal academic and, consequently, increased inflow of women from lower into higher academic positions. Again, this was identified as a positive feedback loop, indicating that increasing the proportion of women in academic positions increases the visibility of women academics, while decreasing the proportion of women in academic positions decreases the visibility of women academics.

*Feedback process of women's networks*
The third feedback process related to women's networks. The variable of networks of women academics was identified by respondents in both universities to relate to the upward career mobility of women academics:

> Sure, you can see all kinds of alliances appearing and, if women are on the Board, they'll make sure that women will get into other positions. (Assistant Professor at the Social Sciences and Humanities University, woman).

> Traditionally it's a bit of a man's world, so networking and that sort of thing is traditionally easier [for men] (Assistant Professor at Technology University, man).

If women academics are part of relevant networks, this supports the flow of (other) women academics to higher academic positions, but if they are absent from these networks, it hinders their upward career mobility. This self-reinforcing feedback process shares similar variables with the previous one, but represents the direct opportunities for career mobility offered by women's networks. This was identified as a positive feedback loop (Figure 2). When women make up a larger proportion of relevant networks, networks become more effective for women, supporting their careers in the academic world. In contrast, when the proportion of women in relevant networks decreases, it negatively affects the careers of (other) women academics.

## Specific features of the Social Sciences and Humanities University
Although there were similarities in the generic structure of the cases at both universities, we also found feedback processes specific to the particular university. We first discuss the specific features of the Social Sciences and Humanities University.

*Budget vs merit principle*
The principles guiding personnel policy at the different schools of the Social Sciences and Humanities University (see van Engen *et al.*, 2008) were important to understand hiring and promotion of women academics. Comparing notes from interviewees in different schools indicated that schools using a merit principle have faster promotion processes than schools using a budget principle. The merit principle dictates that whenever someone meets the requirements for promotion, he or she is promoted immediately. The budget principle dictates that someone who is suitable for a higher function is promoted only when the faculty has sufficient staff positions available.

The external inflow of women into higher academic positions and the promotion of women from lower to higher academic positions are related to the number of staff positions available. Our analysis shows that upward career mobility is slower for all academics when fewer positions are available. As the proportion of men is larger in the higher age groups, their (partial) replacement by younger women will take place at a slower pace when a budget principle dominates personnel management. Moreover, the budget principle affects the outflow of women from lower academic positions. The frustration at not getting promoted has led to a number of women leaving this university or academia in general:

> Yeah, exactly. So then you get a performance review and […] uh […] then you ask, well hi there, what are my chances of getting promoted? And then the dean says something like, "Well yes, but I have so many people with kids around here and these people don't even have permanent positions." So clearly, there are just very few opportunities to advance (Assistant Professor at the Social Sciences and Humanities University, woman).

This is a self-reinforcing feedback process, illustrated in Figure 3 by a positive feedback loop. The more the university uses a budget principle in personnel policies, the more negatively it affects women's academic careers and vice versa.

*Correction of publication productivity targets*
In the Social Sciences and Humanities University, research time is allocated on the basis of earlier publication productivity. When more women are in higher academic positions, it is more likely that the implemented policies correct publication productivity for pregnancy or parental leave and for part-time work (Figure 3):

> Yes, I suppose I should publish more. It's also a matter of appreciation and no, I don't feel I rate very highly. Then again, I took parental leave, straight after they [the twins] were born. That was twice times 18 months, for one day a week. [...] They didn't take this into account when they calculated the output (Assistant Professor at the Social Sciences and Humanities University, man).
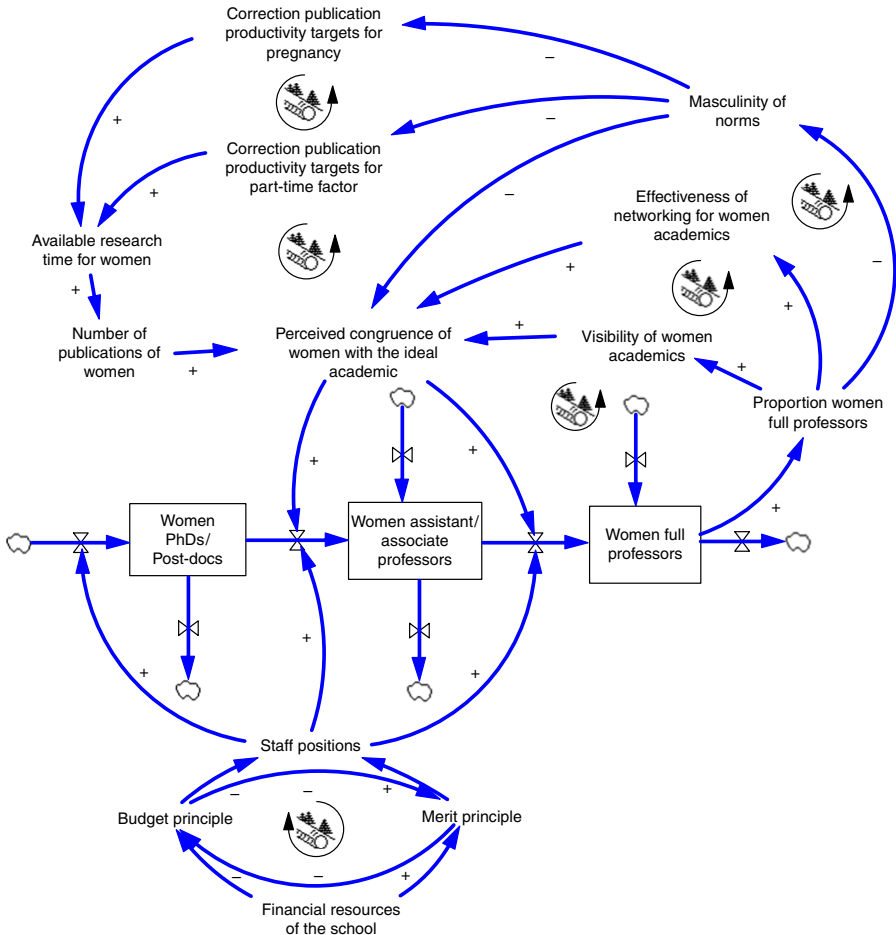


**Figure 3.**
Gender inequality at the Social Sciences and Humanities University

Correction of publication productivity targets for care giving tasks would offer mainly women academics, but also men academics with care giving responsibilities, more research time to invest in publications and consequently lead to a higher publication productivity. This would increase the congruence of women academics with the image of the ideal scientist, thus decreasing the proportion leaving the university and increasing the proportion of women promoted to higher academic positions. This is a self-reinforcing feedback process, illustrated with a positive feedback loop (Figure 3).

## Specific features of the Technical University
We identified two feedback processes specific to the Technical University, which we illustrate below.

### Motivation of women PhD students and post-docs
The lack of motivation of Dutch women PhD students and post-docs to pursue an academic career in technology was identified as a problem in the context of the Technical University:

> In other parts of the world, it is far more common for women to be at a technical university (Assistant Professor at Technology University, woman).

The motivation of women academics to pursue an academic career is a self-reinforcing feedback process affecting the promotion of women academics at every level of the university (Figure 4). The more women PhD students and post-docs are motivated to pursue an academic career in technology, the higher the proportion of women flowing to higher academic professor positions. This decreases the masculinity of norms and increases the visibility of women academics, which subsequently increases the motivation of women to pursue an academic career in technology. This positive feedback loop process also works the other way around.

### Women academics in business
The number of women academics in business was the second variable identified to influence negatively women academics' upward career mobility at the Technical University. During the modelling sessions, deans and department heads argued that wages are considerably higher in the business world and that sometimes assistant and associate professors are lured away with high compensation schemes. An increase in the number of women academics who turn to the business world in principle decreases the number of women promoted to higher academic positions. Participants also identified ways to counter this self-reinforcing feedback process. If a talent-tracking system is deployed, women academics who have left university can be tracked and invited to return in a later phase of their careers (Figure 4). Participants reported this measure as a way of retaining women academics.

## Discussion
Our study showed that participatory modelling involves stakeholders in the problem definition and analysis of gender inequality and supports them to identify possible interventions. Discussing gender inequality in two Dutch universities with deans, faculty and HR officers highlighted the feedback processes that hinder women's careers in these organisations.

The involvement of both researchers and stakeholders in the modelling process supported the integration of empirical knowledge derived from the personnel system,
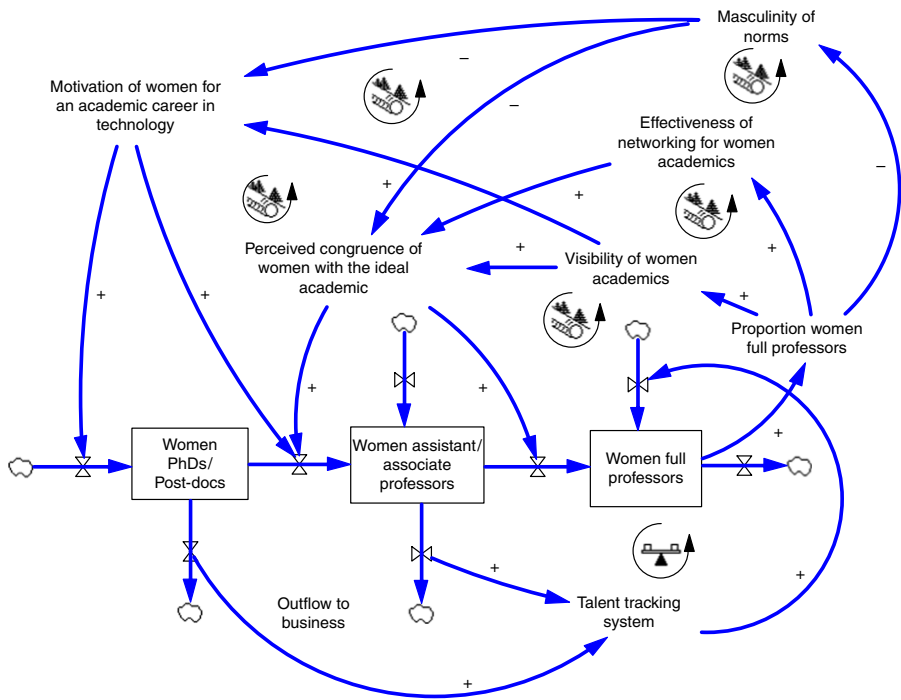
Figure 4.
Gender inequality at the Technical University

**Note:** The balance represent a negative feedback loop – a balancing feedback process between a (series of) variables

in-depth interviews and focus groups, with the day-to-day knowledge of stakeholders. Building causal loop diagrams together helped to elicit and discuss implicit knowledge and resulted in a shared understanding of the problem. The causal loop diagrams showed three generic and four university specific feedback processes that are subsequently discussed.

The first basic element in the causal loop diagrams produced at both universities was the feedback process of masculinity of norms. The perceived lack of congruence of women with the image of the ideal academic negatively affects the proportion of women full professors in the organisation. The incongruence, or "lack of fit", between characteristics of the "ideal" worker and expectations connected to the female gender role has been extensively demonstrated in past research (e.g. Eagly and Karau, 2002; Eagly and Carli, 2007; Heilman, 2012; Rudman and Phelan, 2008). Moreover, the culture of masculinity was found in earlier research about gender in Dutch academia (Benschop and Brouns, 2003; Bleijenbergh *et al.* 2013a; Van den Brink and Benschop, 2012) and has also been identified in academia in the UK (Knights and Richards, 2003), Finland (Määttä and Dahlborg Lyckhage, 2011) and the USA (Bailyn, 2003). Connecting these variables in a causal loop diagram showed that this is a self-reinforcing feedback process.

A second feedback process relates to the visibility of women. As the overall proportion of women in higher academic positions increases, so too does their visibility in and outside the organisation. In turn, there is greater perception of the congruence of women with the ideal academic, which feeds back into the inflow of women from lower

into higher academic positions. Indeed, literature suggests that visibility positively relates to the career progress of women in academia (Van den Brink, 2009). We show this is a self-reinforcing process.

A third feedback process relates to the effectiveness of women's network. When women make up a larger proportion of relevant networks, networks would become more effective for them, supporting their careers in the academic world. This causal link has also been suggested in theoretical literature discussing networking in Swedish and Dutch academia (Husu 2004; Van den Brink and Benschop, 2014). By showing how the present proportion of women in higher academic positions feeds back into the effectiveness of their networks we show this is a self-reinforcing feedback process.

The modelling also revealed four university specific feedback processes. At the Social Sciences and Humanities University we identified how the use of a budget principle for personnel policies effectively slows down the upward mobility of all academics, but particularly that of women, thereby delaying the achievement of gender equality. Academic literature suggests that Anglo-Saxon countries with an emphasis on the merit principle in academia have a relatively faster route towards gender equality (Bailyn, 2003). Second we identified how adaptation of productivity targets for part-time work and leave may increase research time and so publication productivity of women. Indeed, research suggests that generous leave policies lead to increased journal publications of women academics (Feeney *et al.*, 2014). A specific feature at the university of Technology is the feedback process of the motivation of women PhD students and post-docs to take on an academic career in technology. A qualitative study on women in Science and Technology in the USA shows how the motivation of women to work in this field is indeed strongly influenced by organisational context (Rhoton, 2011). Fourth, women academics leave academia to business and can be deployed via a talent-tracking system. The need for talent tracking in academia has been identified in a study by Van Arensbergen (2014). Part of the causal loop diagrams thus appeared to be context dependent, which had implications for the practical consequences.

*Practical consequences*
Understanding how the different feedback processes are interrelated helped stakeholders to identify possible interventions to support gender equality in organisations. The causal loop diagram, for example, shows that correction of publication productivity targets for care giving tasks would lead to higher publication productivity and so increase the congruence of women academics with the image of the ideal scientist and so support their careers. Moreover, the outflow of women academics to business could be addressed by talent-tracking systems. In the two case-study organisations, the identification of the interrelation between the different feedback processes certainly resulted in the identification of interventions. For example, concerning masculinity of norms, the Social Sciences and Humanities University introduced a correction of publication productivity targets for those taking care leave and part-timers, and for paid research sabbaticals following maternity leave. The Technology University introduced the paid research sabbatical following maternity leave, and relieved the prohibition of flexible working schemes. Concerning visibility of women, the Social Sciences and Humanities University installed a task force that monitors the visibility of women researchers in internal and external communication. Since 2011, selection committees (containing at least one woman) at the Technology University have had to put forward at least three highly qualified women in the discipline on the shortlist of possible candidates for full professors.

*Contribution to theory*

The identification of feedback processes explaining gender inequality in organisations is the first contribution of this study to the literature on interventions to support gender equality in organisations. Although the influence of masculinity of norms, visibility of women and networks of women on gender inequality in organisations has been identified before, these relationships have not been explicitly recognised as feedback processes, so ignoring their circular causality. Identifying feedback processes may help to understand the structural processes surrounding gender inequality in organisations and the way they may reinforce themselves. The integration of the feedback processes in a causal loop diagram is the second specific contribution of this research. A causal loop diagram visualises how the different feedback processes are interrelated and can balance or reinforce themselves. Moreover, it allows for the identification of possible interventions. The third contribution of this study is showing how integrating the knowledge of researchers and stakeholders in a causal loop diagram supports the learning of stakeholders about the issue of gender inequality. Participatory modelling reconciles the contradiction between addressing individuals or addressing organisational structures (Ely and Meyerson, 2000; Benschop and Verloo, 2006), since it involves individuals in understanding structural processes and so potentially supports transformational change. Moreover, it entails a training method that supports organisations' responsibility (Kalev *et al.*, 2006) for gender equality as well. The literature on participatory modelling (Rouwette *et al.* 2015; Vennix, 1996) emphasises the importance of including organisational stakeholders in the modelling process to increase commitment and facilitate implementation of interventions. In both universities the boards were quick to accept the outcomes and recommendations, and started developing interventions soon after the projects were rounded off. Thus, participatory modelling contributed to support transformative change from within the organisation in a direction that could not be predicted before, in contrast to the mainstream understanding of change as decided upon in advance, and assumed to emanate from above (Barry *et al.*, 2011). It increased organisational responsibility for gender equality by involving deans and managers, who are accountable for reaching the targets of gender policies (cf. Bendl and Schmidt, 2011; Bleijenbergh *et al.*, 2013b). Therefore, rather than being a top-down approach, it is a bottom-up approach involving the stakeholders. As a result, in both universities the Board explicitly supported the findings of the research projects and began to develop and implement interventions.

*Limitations*

The two cases describe qualitative system dynamics models in the sense that they reflect the consensus between the stakeholders about explanatory mechanisms underneath gender inequality in their organisation. Further testing of these models by quantifying the stocks and the flows in the model, i.e. adding values to all variables in the model (Barlas, 1998), could validate the feedback processes and the estimated effects of possible interventions. This might even boost the effectiveness of participatory modelling, yet is complex and time consuming. Future research could investigate the potential contribution of quantifying the system dynamic model to the effectiveness of gender equality interventions.

The involvement of stakeholders in the analysis of the structural processes around gender inequality in organisations is not only the strength but also the weakness of participatory modelling. Participatory modelling calls for a relatively large time

investment of organisational stakeholders, which may cause resistance, particularly in the start-up phase of the intervention. A second problem is that the shared understanding of the structural processes of gender inequality and the commitment to possible interventions may be limited to the particular stakeholders that participated in the modelling effort As soon as these stakeholders leave their management positions, the knowledge they have acquired on the issue may leave the organisations as well. Only when this knowledge has become part of the "organisational discourse" will it be reproduced and so be able to transform the organisation structurally.

## Conclusions

This study discusses the results of participatory modelling on gender equality by involving stakeholders in the analysis of the problem and identification of interventions. We applied participatory modelling in two case studies to integrate empirical research on gender inequality in academia with the day-to-day knowledge of organisational stakeholders. The case studies took place in a national context of a low representation of women in higher positions in academia, but the processes identified may be relevant in other contexts as well. Participatory modelling resulted in causal loop diagrams that explained the impediment of women's careers in academia. A central element in the causal loop diagrams produced was the perceived lack of congruence of women with the image of the ideal academic, which feeds back into the proportion of women full professors in the organisation. As the overall proportion of women in higher academic positions increases, so too does their visibility in and outside the organisation. In turn, there is greater perception of congruence of women with the ideal academic and, consequently, increased inflow of women from lower into higher academic positions. When women make up a larger proportion of relevant networks, networks would become more effective for them, supporting their careers in the academic world.

We discussed how the inductively derived knowledge fits the results of earlier research on gender equality. The first contribution of this research is the identification of feedback processes explaining gender inequality in organisations, showing the circular causality of single causes and effects that have been identified earlier. The second contribution is that we show how these feedback processes are interrelated and so can reinforce or stabilise themselves. This helps to understand the dynamic processes explaining gender inequality. The third contribution is that we showed how integrating the knowledge of researchers and stakeholders in a causal loop diagram supports the learning of stakeholders about the issue of gender inequality. Participatory modelling supported validation of the analysis with organisational stakeholders and, as a consequence, ensured their commitment to the results. Both universities identified and implemented a considerable number of gender equality interventions following the participatory modelling process.

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